

What is claimed is:

1. A method for improvement of edge breakdown caused by edge electrical field at a tunnel oxide of a high-density
5 flash memory by a shielded bird's beak, the method comprising the steps of:

forming a plurality of trenches on a substrate, for isolating a plurality of active regions;
10 forming a liner oxide on the plurality of trenches and extending to respective edges of the plurality of active regions;
depositing a first oxide filled in the plurality of trenches for forming a plurality of shallow trench isolations;
15 depositing a second oxide for covering the plurality of shallow trench isolations and active regions;
etching the second oxide for forming a plurality of bird's beak spacers at the respective edges of the plurality of active regions; and
20 forming a tunnel oxide layer on the plurality of active regions.

2. The method according to claim 1, wherein the step of forming a plurality of trenches comprises the steps of:

25 forming a pad nitride on the substrate;

defining a pattern for the plurality of shallow trench isolations on the pad nitride; and etching the substrate with the pad nitride as a mask for forming the plurality of trenches.

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3. The method according to claim 1, wherein the step of forming a plurality of shallow trench isolations comprises the steps of:

10 depositing the first oxide by a high-density plasma deposition; and chemical-mechanical polishing the first oxide.

15 4. The method according to claim 1, wherein the step of forming a second oxide comprises a high-temperature oxide deposition.

5. The method according to claim 1, further comprising the steps of:

20 forming a sacrificial oxide on the plurality of the active regions after the formation of a plurality of bird's beak spacers; and removing the sacrificial oxide.

25 6. The method according to claim 1, wherein the liner oxide forms a plurality of initial bird's beaks at the

respective edges of the plurality of active regions.

7. The method according to claim 6, wherein the bird's beak spacers are self-aligned to and shield the plurality of initial bird's beaks.

8. A method for improvement of edge breakdown caused by edge electrical field at a tunnel oxide of a high-density flash memory by a shielded bird's beak, the method comprising the steps of:

depositing a pad nitride on a substrate;

defining a pattern for an active region and a shallow trench isolation on the pad nitride;

etching the substrate with the pad nitride as a mask for forming a trench;

forming a liner oxide on the trench and extending to an edge of the active region for intruding under the pad nitride to form a bird's beak;

depositing a first oxide filled in the trench and covering on the pad nitride;

polishing-back the first oxide;

removing the pad nitride;

depositing a second oxide for covering the first oxide and active region;

etching the second oxide for forming a bird's beak

spacer at an edge of the active region; and
forming a tunnel oxide layer on the active region.

9. The method according to claim 8, wherein the
5 step of forming a liner oxide comprises a high-temperature
oxidation at a temperature of about 1100-1200 °C.

10. The method according to claim 8, wherein the
step of depositing a first oxide comprises a high-density plasma
10 deposition at a temperature of about 400-550 °C.

11. The method according to claim 8, wherein the
step of polishing-back the first oxide comprises
chemical-mechanical polishing with the pad nitride as a
15 etch-stop layer.

12. The method according to claim 8, wherein the
step of depositing a second oxide comprises a high-temperature
oxide deposition at a temperature of about 800-900 °C.

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13. The method according to claim 12, wherein the
first and second oxides are fused with each other.

14. The method according to claim 8, wherein the
25 step of etching the second oxide comprises an over-etching of a

thickness of the substrate at the active region.

15. The method according to claim 8, further comprising the steps of:

5 forming a sacrificial oxide on the active region after the formation of the bird's beak spacer; and removing the sacrificial oxide.